CERTIFICATE

I, Hajime KURAMASU, residing at 1-1036-14, Ogawa-cho, Kodaira-shi, Tokyo, 187-0032 Japan, hereby certify that I am the translator of the attached document, namely a Certified Copy of Japanese Patent Application No. 2000-154697 and certify that the following is a true translation to the best of my knowledge and belief.

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March 4, 2004

Date

[Name of Document]	Application for Patent
[Reference No.]	J0079056
[Date of Filing]	May 25, 2000
[Addressee]	Commissioner of the Patent Office
[Int. Cl.]	G02F 1/1335 520
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[Application Fees]

[Prepayment Registration No.] 013044

[Amount of Payment] 21000

[List of Documents Attached]

[Name of Document] Specification 1

[Name of Document] Drawings 1

[Name of Document] Abstract 1

[No. of General Power of Attorney] 9711684

[Proof] Required

[Name of Document] SPECIFICATION

[Title of the Invention] LIQUID CRYSTAL DEVICE, METHOD FOR MAKING THE SAME, AND ELECTRONIC DEVICE

[Claims]

[Claim 1] A liquid crystal device comprising a first substrate and a second substrate bonded to each other with a frame of a sealant at a predetermined gap and a liquid crystal enclosed in the gap, the liquid crystal device further comprising:

a first transparent electrode provided on the inner face opposing the second substrate of the first substrate;

an underlying film provided on the inner face opposing the first substrate of the second substrate;

a reflective film which is formed on the underlying film and which contains elemental silver or a silver alloy containing silver;

an insulating protective film formed so as to cover the reflective film; and

a second transparent electrode formed on the protective film.

[Claim 2] A liquid crystal device according to claim 1, wherein a color layer is provided between the protective film and the second transparent electrode at a position corresponding to the crossing region between the first transparent electrode and the second transparent electrode.

[Claim 3] A liquid crystal device according to claim 1,

wherein the protective film protects the reflective film and reflects blue light components.

[Claim 4] A liquid crystal device according to claim 1,

wherein conductors are contained in the sealant or are provided in the exterior of the frame of the sealant; and

a first lead which is connected to the first transparent electrode via the conductors is provided at the inner face of the second substrate;

the first lead comprising:

a reflective conductive film formed on the underlying film and comprising the same layer as that for the reflective layer; and

a transparent conductive film formed by patterning the same layer as that for the second transparent electrode so as to be deposited on the reflective conductive film and to come into contact with the underlying film at the edge portion thereof.

[Claim 5] A liquid crystal device according to claim 4,

wherein the first lead is not provided with the reflective conductive film at the portion connected to the conductors.

[Claim 6] A liquid crystal device according to claim 4,

wherein a driver IC chip for driving the first transparent electrode via the first lead is mounted at the

inner face of the second substrate.

[Claim 7] A liquid crystal device according to claim 6,

wherein the first lead is not provided with the reflective conductive film at a portion connected to the electrodes of the driver IC chip.

[Claim 8] A liquid crystal device according to claim 6,

wherein a second lead which is extracted from a portion connected to a flexible printed circuit board to a portion connected to the electrodes of the driver IC chip is provided on the inner face of the second substrate;

the second lead comprising:

a reflective conductive film formed on the underlying film and comprising the same layer as that for the reflective layer; and

a transparent conductive film formed by patterning the same layer as that for the second transparent electrode so as to be deposited on the reflective conductive film and to come into contact with the underlying film at the edge portion thereof.

[Claim 9] A liquid crystal device according to claim 8,

wherein the second lead is not provided with the reflective conductive film at a portion connected to the flexible printed circuit board and a portion connected to electrodes of the driver IC chip.

[Claim 10] A liquid crystal device according to claim 1,

wherein a reflective conductive film which is formed on the underlying film below the second transparent electrode and which comprises the same layer as that for the reflective layer is patterned so as to be one size smaller than the second transparent electrode, and

the second transparent electrode is patterned so as to come into contact with the underlying film at the edge portion thereof.

[Claim 11] A liquid crystal device according to claim 10,

wherein a driver IC chip for driving the second transparent electrode via a laminate film including the transparent conductive film is mounted on the inner face of the second substrate.

[Claim 12] A liquid crystal device according to claim 10,

wherein the second transparent electrode is not provided with the reflective conductive film at a portion connected to the electrodes of the driver IC chip.

[Claim 13] A liquid crystal device according to claim 11,

wherein a third lead which is extracted from a portion connected to a flexible printed circuit board to a portion connected to the electrodes of the driver IC chip is provided on the inner face of the second substrate;

the third lead comprising:

a reflective conductive film formed on the underlying film and comprising the same layer as that for

the reflective layer; and

a transparent conductive film formed by patterning the same layer as that for the second transparent electrode so as to be deposited on the reflective conductive film and to come into contact with the underlying film at the edge portion thereof.

[Claim 14] A liquid crystal device according to claim 13,

wherein the third lead is not provided with the reflective conductive film at a portion connected to the flexible printed circuit board and a portion connected to the electrodes of the driver IC chip.

[Claim 15] A liquid crystal device according to claim 1,

wherein the reflective film is patterned into substantially the same shape as that of the second transparent electrode and is electrically connected to the second transparent electrode.

[Claim 16] A liquid crystal device according to claim 1,

wherein the reflective film is provided with an opening at the position corresponding to the crossing with the first transparent electrode.

[Claim 17] An electronic device comprising a liquid crystal device according to any one of claims 1 to 16.

[Claim 18] A method for making a liquid crystal device comprising a first substrate and a second substrate, the electrode-forming faces thereof being bonded to each other

with a predetermined gap and a liquid crystal being enclosed in the gap, the liquid crystal device comprising the steps of:

providing an underlying film on the inner face opposing the first substrate of the second substrate;

forming a reflective film comprising elemental silver or a silver alloy containing silver on the underlying film;

forming an insulating protective film so as to cover the reflective film;

forming the second transparent electrode on the protective film.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to reflective and transflective liquid crystal devices which use silver alloys and the like to reflect light, to a method for making the same, and to electrooptical devices using the liquid crystal devices as display sections.

[0002]

[Description of the Related Art]

As is well known, liquid crystal devices do not emit light but performs display by controlling the polarization state of light. Thus, it is necessary that the configuration be such that light is incident on a panel of

the liquid crystal device, and in this regard, they are quite different from other display devices, such as electroluminescent devices and plasma display devices.

[0003]

Herein, the liquid crystal devices are classified into two types, that is, a transmissive type in which a light source is provided behind the panel and the light passing through the panel is observed by a viewer, and a reflective type in which a light source is provided on the front side of the panel (or the light source is not provided) and the light incident from a viewer side and reflected by a panel is observed by a viewer.

[0004]

In the transmissive type, the light emitted from the light source provided at the rear side of the panel (thus, called backlight) is introduced to the entire panel through a light guide plate. Then, the light passes through a polarizer, a back substrate, an electrode, a liquid crystal, another electrode, a viewer-side substrate, and another polarizer and is observed by the observer. On the other hand, in the reflective type, the light incident on the panel passes through a polarizer, a viewer-side substrate, an electrode, a liquid crystal, and another electrode, is reflected by a reflective film, and passes through the path in the reverse direction, and is observed by a viewer.

Thus, the reflective type has twice the optical path including an incident path and a reflected path and large optical losses occur in both paths. Compared to the transmissive type, the amount of light from the surrounding environment (external light) is less than that of a light source disposed at the rear side of the panel. Since only a small amount of light is observed by the viewer, the display is dim. However, the reflective type also has noticeable advantages, such as high outdoor visibility under sunlight and an ability to display without a light source, compared with the transmissive type. Thus, the reflective liquid crystal devices are widely used in display sections of portable electronic devices and the like.

[0005]

The reflective type, however, has a notable disadvantage in that the viewer cannot see the display when insufficient natural illumination is provided from the environment. In recent years, a transflective type has appeared in which a backlight is provided at the rear face of a panel, and a reflective film not only reflects the light incident from the viewer's side and but also transmits some of the light from the rear face. This transflective type functions both as a transmissive type by switching on the backlight to ensure visibility of the display when there is insufficient external light and as a reflective type by

extinguishing the backlight in order to reduce power consumption when there is sufficient external light. This means, the transmissive type or the reflective type is selected depending on the intensity of the external light to ensure visibility of the display and to reduce power consumption.

[0006]

In the reflective type and the transflective type, aluminum has been generally used as a material for the reflective film. However, in recent years, the use of elemental silver or a silver alloy primarily composed of silver (hereinafter referred to as merely "silver alloy") has been investigated to improve reflectance for achieving bright display.

[0007]

[Problems to be Solved by the Invention]

However, in a liquid crystal device, a problem arises in that the reflectance of the reflective film formed of the silver alloy decreases when the film is subjected to any high-temperature treatment, and the reason for use of the silver alloy in the reflective film disappears.

[0008]

The present invention has been realized in view of the above circumstances. It is an object thereof to provide a liquid crystal device having a reflective film of a silver

alloy in which a decrease in reflectance does not occur during a high-temperature treatment, a method for making the device, and an electronic device.

[0009]

[Means for Solving the Problems]

The present inventor concluded that a decrease in reflectance of the reflective film which is composed of a silver alloy during the high-temperature treatment is caused by the crystal grain (grain scale) growth in the reflective film during the high-temperature treatment. A liquid crystal device in accordance with the present invention comprises a first substrate and a second substrate bonded to each other with a frame of a sealant at a predetermined gap and a liquid crystal enclosed in the gap, the liquid crystal device further comprising a first transparent electrode provided on the inner face opposing the second substrate of the first substrate, an underlying film provided on the inner face opposing the first substrate of the second substrate, a reflective film which is formed on the underlying film and which contains elemental silver or a silver alloy containing silver, an insulating protective film formed so as to cover the reflective film, and a second transparent electrode formed on the protective film. According to such a configuration, the protective film is formed to cover the entire surface of the reflective layer

formed of a silver alloy. Since the growth of crystal grains constituting the reflective layer is suppressed, a decrease in reflectance is prevented.

[0010]

Preferably, in the present invention, a color layer is provided between the protective film and the second transparent electrode at a position corresponding to the crossing region between the first transparent electrode and the second transparent electrode. The color layer is generally composed of a resin containing a pigment and requires a high-temperature treatment for being dried and cured. According to such a configuration, when the color layer is formed after the reflective layer is formed, a decrease in reflectance of the reflective layer during the high-temperature treatment for forming the color layer is prevented.

[0011]

Meanwhile, the reflectance of silver or a silver alloy is superior in the entire visible light region, but is not so flat as that of aluminum and tends to decrease at the shorter wavelength side (see Fig. 10). As a result, the light reflected by the reflective film less contains blue light components and thus is yellowish. Thus, it is preferable in the present invention that the protective film protects the reflective film and reflects the blue light

components. Since large amounts of blue light components are reflected by the protective film before the components are reflected by the reflective film, the reflected light is not yellowish.

[0012]

In the present invention, preferably, conductors are contained in the sealant or are provided in the exterior of the frame of the sealant, and a first lead which is connected to the first transparent electrode via the conductors is provided at the inner face of the second substrate, the first lead comprising a reflective conductive film formed on the underlying film and comprising the same layer as that for the reflective layer, and a transparent conductive film formed by patterning the same layer as that for the second transparent electrode so as to be deposited on the reflective conductive film and to come into contact with the underlying film at the edge portion thereof. According to this configuration, the first transparent electrode provided on the first substrate is connected to the first lead provided on the second substrate; hence, leads connected to an external circuit are arranged on the second substrate, simplifying the connection step. Since the first lead includes a laminate film of the reflective conductive film and the transparent conductive film, the resistance thereof is decreased compared to the single

layer. Since the transparent conductive film deposited on the reflective conductive film covers the reflective conductive film and the edge portion thereof is patterned so as to come into contact with the underlying film, the interface of the reflective conductive film is not exposed after the conductive layer constituting the transparent conductive film is deposited. Thus, the reflective conductive film composed of a silver alloy is prevented from corrosion and separation due to moisture which enters from the interface in the present invention, ensuring high reliability.

[0013]

Preferably, in this configuration, the first lead is not provided with the reflective conductive film at the portion connected to the conductors. Since the silver alloy is readily damaged by mechanical friction and is readily corroded and separated by moisture which enters from the interface thereof due to poor adhesion to other materials, it is undesirable to provide at a position in which a stress is applied.

[0014]

In this configuration, preferably, a driver IC chip for driving the first transparent electrode via the first lead is mounted at the inner face of the second substrate. Such mounting of the driver IC chip for driving the first

transparent electrode can reduce the number of connections to the external circuit.

[0015]

When the driver IC chip for driving the first transparent electrode is provided on the inner surface of the second substrate, the first lead is preferably not provided with the reflective conductive film at a portion connected to the electrodes of the driver IC chip. It is not desirable that the silver alloy be provided at a position in which a stress is applied since the alloy has poor adhesion, as described above. When the driver IC chip is detached from the second substrate for repairing, the reflective conductive film may be separated.

[0016]

When the driver IC chip for driving the first transparent electrode formed on the first substrate is provided on the inner face of the second substrate, it is preferable that a second lead which is extracted from a portion connected to a flexible printed circuit board to a portion connected to the electrodes of the driver IC chip is provided on the inner face of the second substrate, wherein the second lead comprises a reflective conductive film formed on the underlying film and comprising the same layer as that for the reflective layer, and a transparent conductive film formed by patterning the same layer as that

for the second transparent electrode so as to be deposited on the reflective conductive film and to come into contact with the underlying film at the edge portion thereof. According to this configuration, the second lead is composed of a laminate film of the reflective conductive film and the transparent conductive film; hence, the resistance thereof is reduced compared to the case of any single-layer, and the interface of the reflective conductive film is not exposed, ensuring high reliability.

[0017]

Preferably, the second lead is not provided with the reflective conductive film at a portion connected to the flexible printed circuit board and a portion connected to electrodes of the driver IC chip. Since the silver alloy has poor adhesion as described above, it is not desired to provide the alloy at a position in which a stress is applied. When the repair section is detached from the second substrate to repair the flexible printed circuit board or the driver IC chip, the reflective conductive film may also be separated.

[0018]

In the present invention, preferably, a reflective conductive film which is formed on the underlying film below the second transparent electrode and which comprises the same layer as that for the reflective layer is patterned so

as to be one size smaller than the second transparent electrode, and the second transparent electrode is patterned so as to come into contact with the underlying film at the edge portion thereof.

[0019]

Preferably, a driver IC chip for driving the second transparent electrode via a laminate film including the transparent conductive film is mounted on the inner face of the second substrate. The mounting of the driver IC chip for driving the second transparent electrode can reduce the number of connections to the external circuit.

[0020]

When the driver IC chip for driving the second transparent electrode is provided on the inner surface of the second substrate, the second transparent electrode is preferably not provided with the reflective conductive film at a portion connected to the electrodes of the driver IC chip. Since the silver alloy has poor adhesion as described above, the alloy may be detached during repairing.

[0021]

When the driver IC chip for driving the second transparent electrode is provided on the inner face of the second substrate, it is preferable that a third lead which is extracted from a portion connected to a flexible printed circuit board to a portion connected to the electrodes of

the driver IC chip be provided on the inner face of the second substrate, wherein the third lead comprises a reflective conductive film formed on the underlying film and comprising the same layer as that for the reflective layer, and a transparent conductive film formed by patterning the same layer as that for the second transparent electrode so as to be deposited on the reflective conductive film and to come into contact with the underlying film at the edge portion thereof. Since the third lead is composed of a laminate film of the reflective conductive film and the transparent conductive film in this configuration, the resistance thereof is reduced compared to a case of any single layer. Since the interface of the reflective conductive film is not exposed, high reliability is ensured.

[0022]

Preferably, the third lead is not provided with the reflective conductive film at a portion connected to the flexible printed circuit board and a portion connected to the electrodes of the driver IC chip. Since the silver alloy has poor adhesion as described above, it is not desirable to provided the alloy at a position in which a stress is applied. When the repairing section is detached from the second substrate to repair the flexible printed circuit board or the driver IC chip, the reflective conductive film may also be detached.

[0023]

Preferably, the reflective film is patterned into substantially the same shape as that of the second transparent electrode and is electrically connected to the second transparent electrode. This configuration prevents capacitive coupling between the second transparent electrode and the reflective layer.

[0024]

Preferably, the reflective film is provided with an opening at the position corresponding to the crossing with the first transparent electrode. This configuration enables not only display by the light reflected by the reflective layer but also display by the light passing through the opening.

[0025]

Since an electronic device is provided with the above-mentioned liquid crystal device in a display region, a decrease in reflectance of the reflective layer during a high-temperature treatment after the reflective film is formed is prevented, enabling a bright reflective-type display.

[0026]

In a method for making a liquid crystal device according to the present invention for achieving the above object comprising a first substrate and a second substrate,

the electrode-forming faces thereof being bonded to each other with a predetermined gap and a liquid crystal being enclosed in the gap, the method for making the liquid crystal device comprises the steps of: providing an underlying film on the inner face opposing the first substrate of the second substrate, forming a reflective film comprising elemental silver or a silver alloy-containing silver on the underlying film, forming an insulating protective film so as to cover the reflective film, forming the second transparent electrode on the protective film. Since the protective film formed so as to cover the reflective layer formed of the silver alloy suppress the crystal grain growth in the reflective layer during a high-temperature treatment after the reflective layer is formed in this method, a decrease in reflectance is prevented.

[0027]

[Description of the Embodiments]

The Embodiments of the present invention will be described with reference to the drawings.

[0028]

<Overall Configuration>

A liquid crystal device in accordance with the present invention will now be described. This liquid crystal device is of a transflective type which functions as a reflective type when external light is sufficient and as a transmissive

type by switching on a backlight when the external light is insufficient. Fig. 1 is an isometric view illustrating an overall configuration of a liquid crystal panel in the liquid crystal device. Fig. 2 is a partial cross-sectional view when the device is broken along the X direction in Fig. 1, and Fig. 3 is a partial cross-sectional view when the device is broken along the Y direction in Fig. 1.

[0029]

As shown in these drawings, the liquid crystal panel 100 constituting the liquid crystal device includes a viewer-side substrate 200 lying at the viewer side and a backside substrate 300 lying at the back side, these substrates being bonded to each other at a predetermined gap with a sealant 110 which contains conductive particles 114 and also functions as a spacer. This gap is filled with, for example, a twisted nematic (TN) liquid crystal 160. The sealant 110 is formed on either substrate to form a frame along the peripheries of the inner face of the viewer-side substrate 200 and has an opening for enclosing the liquid crystal 160. This opening is sealed with a sealant 112 after the liquid crystal is enclosed.

[0030]

A plurality of common (scanning) electrodes 214 extends in the X (line) direction on the inner face of the viewer-side substrate 200, whereas a plurality of segment (data)

electrodes 314 extends in the Y (row) direction on the inner face of the backside substrate 300. In this embodiment, a voltage is applied to the liquid crystal 160 through these electrodes at regions in which the segment electrodes (first transparent electrodes) 314 and the common electrodes (second transparent electrodes) 214 cross each other, and this crossing regions function as sub-pixels.

[0031]

In the backside substrate 300, a driver (driving circuit) IC chip 122 for driving the common electrodes 214 and a driver IC chip 124 for driving the segment electrodes 314 are mounted on two sides which protrude from the viewer-side substrate 200 by a chip-on-glass (COG) technology, as described below. At the exterior of the region for mounting the driver IC chip 124 in these two sides, a flexible printed circuit (FPC) board 150 is bonded.

[0032]

Each common electrode 214 formed on the viewer-side substrate 200 is connected to one end of each lead (first lead) 350 which is formed on the backside substrate 300, via conductive particles 114 contained in the sealant 110. On the other hand, the other end of the lead 350 is connected to an output terminal of the driver IC chip 122. That is, the driver IC chip 122 supplies common signals through the leads 350, the conductive particles 114, and the common

electrodes 214 in that order. Input terminals of the driver IC chip 122 and the FPC board 150 are connected to each other with leads (second leads) 360.

[0033]

The segment electrodes 314 formed on the backside substrate 300 are connected to the output terminal of the driver IC chip 124. That is, the driver IC chip 124 directly supplies segment signals to the segment electrodes 314. The input terminal of the driver IC chip 124 and the FPC board 150 are connected with leads (third leads) 370.

[0034]

As shown in Figs. 2 and 3, in the liquid crystal panel 100, a polarizer 121 and a retarder 123 are provided on the proximal side (viewer side) of the viewer-side substrate 200. Furthermore, a polarizer 131 and a retarder 133 are provided on the backside (away from the viewer) of the backside substrate 300 (not shown in Fig. 1). In addition, a backlight (not shown in the drawings) is provided behind the backside substrate 300 so that the liquid crystal device is used as a transmissive type when the external light is insufficient.

[0035]

<Display Region>

A display region in the liquid crystal panel 100 will now be described in detail. The viewer-side substrate 200

will be described in detail. As shown in Figs. 2 and 3, the retarder 123 and the polarizer 121 are bonded onto the outer face of the viewer-side substrate 200. The inner face of the viewer-side substrate 200 is provided with a plurality of strip common electrodes 214 which are composed of a transparent conductive material such as ITO and which extend in the X direction (the transverse direction in Fig. 2 and the longitudinal direction in Fig. 3) on the planarized plane.

[0036]

An alignment film 208 composed of polyimide or the like is formed on the common electrodes 214 and the substrate 200 and is subjected to rubbing treatment in a predetermined direction before bonding to the back substrate 300. Since the alignment film 208 is unnecessary in regions other than the display region, this is not provided in the vicinity and the exterior of the region of the sealant 110.

[0037]

The configuration of the backside substrate 300 will now be described. The retarder 133 and the polarizer 131 are bonded to the outer face of the backside substrate 300. Furthermore, an underlying film 301 is formed on the entire inner face of the backside substrate 300. In addition, a reflective film 302 is formed on the underlying film 301. The reflective film 302 is formed of elemental silver or a

silver alloy primarily composed of silver and is used for reflecting light incident from the viewer-side substrate 200 towards the viewer-side substrate 200. Preferably, the reflective film 302 has a surface causing irregular reflection rather than a complete mirror surface. Although the reflective film 302 is preferably formed so as to have an uneven surface to some extent, the description thereof is omitted in the present invention since the description does not relates to the present invention directly. The reflective film 302 is provided with two openings 309 per one sub-pixel for transmitting light from the backlight so that the device can be used also as a transmissive type (see Fig. 4). The underlying film 301 provided on the backside substrate 300 improves adhesiveness of the overlying reflective film 302 to the substrate.

[0038]

An insulating protective film 303 is provided so as to cover the reflective film 302 provided with the openings 309. The protective film 303 protects the reflective film 302, prevents a decrease in reflectance of the reflective film 302, and reflects large amounts of blue light components of the light incident from the viewer-side substrate 200.

[0039]

Moreover, color filters 305 are arranged into a

predetermined array corresponding to crossing regions between the common electrodes 214 and the segment electrodes 314. In this embodiment, red (R), green (G), and blue (B) color filters 305 have a stripe arrangement which is suitable for displaying data (see Fig. 4), and three R, G, and B sub-pixels constitute one substantially square pixel. However, the present invention is not limited to this configuration.

[0040]

A planarization film 307 formed of an insulating material planarizes steps due to the color filters 305, and a plurality of strip segment electrode 314 composed of a transparent conductive material such as ITO extends in the Y direction on the planarized plane. An alignment film 208 composed of polyimide or the like is formed on the segment electrodes 314 and the planarization film 307 and is subjected to rubbing treatment in a predetermined direction before bonding with the viewer-side substrate 200.

[0041]

Since the alignment film 308, the underlying planarization film 307, and the protective film 303 are unnecessary in regions other than the display region, these are not provided in the vicinity and the exterior of the region of the sealant 110. A manufacturing process of the back substrate 300 will be described below.

[0042]

<Vicinity of Sealant>

The vicinity of the region of the sealant 110 in the liquid crystal panel 100 will be described with reference to Figs. 2, 3, 4, and 5. Fig. 4 is a perspective plan view of a detailed configuration of leads in the vicinity of the side for mounting the driver IC chip 122 in the region of the sealant 110 when viewed from the viewer, and Fig. 5 is a cross-sectional view taken from line A-A′ in Fig. 4.

[0043]

The common electrodes 214 and the leads 350 will be described. As shown in these drawings, the common electrodes 214 on the viewer-side substrate 200 extend to the region of the sealant 110, whereas transparent conductive films 352 constituting the leads 350 extend to the region of the sealant 110 on the backside substrate 300 so as to face the common electrodes 214. Thus, given amounts of spherical conductive particles 114 dispersed in the sealant 110 function as spacers and electrically connect the common electrodes 214 and the corresponding transparent conductive films 354.

[0044]

Herein, each lead 350 electrically connects the corresponding common electrode 214 and the output terminal of the driver IC chip 122 at the backside substrate 300 and

has a laminate configuration of a reflective conductive film 352 and the corresponding transparent conductive film 354. The reflective conductive film 352 is formed by patterning a conductive layer of elemental silver or a silver alloy primarily composed of silver. The transparent conductive films 354 are formed by patterning the conductive layer of ITO or the like which is the same as that of the segment electrodes 314 so as to be one size larger than the reflective conductive films 352 and, in detail, as shown in Fig. 5, so as to come into contact with the underlying film 301 at the edge portion protruding from the reflective conductive film 352, in cross-sectional view. As shown in Fig. 2 or 4, the reflective conductive films 352 are not formed and only the transparent conductive films 354 are formed in the region for forming the sealant 110.

[0045]

Next, extraction of the segment electrodes 314 to the driver IC chip 122 will be described. As described above, the protective film 303 and the planarization film 307 are not provided in the vicinity and the exterior of the sealant 110. Thus, as shown in Fig. 3, each segment electrode 314 is formed on the underlying film 301 in this region.

[0046]

On the other hand, a reflective conductive film 312 which is obtained by patterning the conductive layer of the

same silver alloy as that of the reflective film 302, and the segment electrode 314 is provided thereon by patterning so as to be one size larger than the reflective conductive film 312, and in detail, as shown in parentheses in Fig. 5, so as to come into contact with the underlying film 301 at the edge portion protruding from the reflective conductive film 312, in cross-sectional view. That is, the segment electrode 314 is extracted as a laminate film 310 including the reflective conductive film 312 to the output terminal of the driver IC chip 124 in the exterior of the frame of the sealant 110.

[0047]

In this embodiment, the reflective film 302 is electrically floating in the interior of the frame of the sealant 110. Thus, the protective film 303, the color filter 305, and the planarization film 307 are preferably formed so that the distance between the reflective film 302 and the segment electrode 314 is approximately 2 μm and each segment electrode 314 and the reflective film 302 do not cause capacitive coupling.

[0048]

The diameter of the conductive particle 114 in Figs. 2 and 3 is larger than the actual size for description and only one particle is depicted in the width direction of the sealant 110. In the actual configuration, however, many

conductive particles 114 are arranged in the width direction of the sealant 110.

[0049]

<Region for Mounting Driver IC and Vicinity of Region for Bonding FPC Board>

Next, regions for mounting the driver IC chips 122 and 124 and the vicinity of a region for connecting the FPC board 150 in the backside substrate 300 will be described. Fig. 6 is a cross-sectional view which primarily illustrates leads among configurations of these regions, and Fig. 7 is a plan view which illustrates the lead configuration in the region for mounting the driver IC chip 122, when viewed from the viewer. Although, the backside substrate 300 is provided with the leads 350, 360 and 370, as well as the segment electrodes 314, as described above, only the leads 350 and 360 relating to the driver IC chip 122 will be described in this embodiment.

[0050]

As shown in these drawings, the leads 350 for supplying the common signal from the driver IC chip 122 to the common electrodes 214 are composed of a laminate film including the reflective conductive films 352 and the transparent conductive films 354. The region for mounting the driver IC chip 122, however, includes only the transparent conductive film 354 and does not include the reflective conductive film

352, as in the region for forming the sealant 110.

[0051]

Each lead 360 for supplying various signals, fed from the FPC board 150, to the driver IC chip 122 is composed of a laminate film including a reflective conductive film 362 and a transparent conductive film 364, like the lead 350. The reflective conductive film 362 is formed by patterning the conductive layer of a silver alloy which is the same as the layer for the reflective layer 302 and the reflective conductive film 352. The transparent conductive film 364 is formed by patterning the conductive layer of ITO or the like which is the same as the layer for the segment electrodes 314 and the transparent conductive films 354 such that the transparent conductive film 364 is one size larger than the reflective conductive film 362 and more specifically such that the edge portion of the transparent conductive film 364 protruding from the reflective conductive film 362 comes into contact with the underlying film 301.

[0052]

In the region for mounting the driver IC chip 122 and the region (not shown in Fig. 7) for bonding the FPC board 150, the leads 360 are provided with only the transparent conductive film 364 and thus not provided with the reflective conductive film 362.

[0053]

The driver IC chip 122 is COG-mounted to these leads 350 and 360, for example, by the following process. A plurality of electrodes is provided at the periphery of a face of the rectangular parallelepiped driver IC chip 122. An extruding electrode (bump) 129a or 129b composed of, for example, gold (Au) is preliminarily formed to each electrode. Then, an anisotropic conductive sheet of an adhesive 130, such as an epoxy adhesive, containing uniformly dispersed conductive particles 134 is placed onto the region for mounting the driver IC chip 122 on the backside substrate 300. The anisotropic conductive sheet is sandwiched by the driver IC chip 122 in which the face provided with the electrodes is arranged at the inner side and the backside substrate 300. After the driver IC chip 122 is positioned, pressure and heat are applied to the backside substrate 300 via the anisotropic conductive sheet.

[0054]

As a result, in the driver IC chip 122, the projection electrode 129a and the projection electrode 129b are electrically connected to the transparent conductive films 354 constituting the leads 350 and the transparent conductive films 364 constituting the leads 360, respectively, via the conductive particles 134 in the adhesive 130. The adhesive 130 also functions as a sealant which protects the electrode-forming-face of the driver IC

chip 122 from moisture, contamination, stress, etc.

[0055]

The leads 350 and 360 relating to the driver IC chip 122 are exemplified above. The leads the relating to the driver IC chip 124, that is, the laminate film 310 from the segment electrode 314 and the leads 370 supplying various signals fed from the FPC board 150 to the driver IC chip 124 have substantially the same configurations as those of the leads 350 and 360, as shown in parentheses in Fig. 6.

[0056]

That is, the segment electrodes 314 for supplying the segment signals from the driver IC chip 124 are provided with the underlying reflective conductive films 312 in the exterior of the frame of the sealant 110, and are not provided with the reflective conductive films 312 in the region for mounting the driver IC chip 124.

[0057]

The leads 370 for supplying various signals fed from the FPC board 150 to the driver IC chip 124 is composed of a laminate of a reflective conductive film 372 and a transparent conductive film 374, as in other leads 350 and 360. The reflective conductive film 372 is formed by patterning the same conductive layer as that for the reflective conductive films 352 and 362. The transparent conductive film 374 is formed by patterning the same

conductive layer as that for the transparent conductive films 314, 354, and 364 such that the transparent conductive film 374 is one size larger than the reflective conductive film 372 and the edge thereof protruding from the reflective conductive film 372 comes into contact with the underlying film 301, as shown in parentheses in Fig. 5.

[0058]

In the region for mounting the driver IC chip 124 and the region for bonding the FPC board 150, only the transparent conductive film 374 of the lead 370 is provided and the reflective conductive film 372 is not provided.

[0059]

These leads 310 and 370 of such laminate films are connected to the driver IC chip 124 via the anisotropic conductive sheet, as in the driver IC chip 122.

[0060]

The anisotropic conductive sheet is also used for connection of the FPC board 150 to the leads 360 and 370. A lead 154 formed on a substrate 152 of polyimide or the like of the FPC board 150 is electrically connected to the transparent conductive film 364 constituting the lead 360 and the transparent conductive film 374 constituting the lead 370 via conductive particles 144 in an adhesive 140.

[0061]

<Manufacturing Process>

A manufacturing process of the above liquid crystal device and particularly of the backside substrate will be described with reference to Figs. 8 and 9. The description is mainly focused to the segment electrode 314 and the lead 350 and the interior (display region) of the sealant frame, the sealant, and the exterior of the sealant frame are separately described.

[0062]

As shown in Fig. 8(a), Ta_2O_5, SiO_2, or the like is deposited on the entire inner face of a backside substrate 300 by sputtering to form an underlying film 301. As shown in Fig. 8(b), a reflective conductive layer 302′ composed of elemental silver or primarily composed of silver is deposited by sputtering or the like. Preferably, the reflective film 302′ is composed of, for example, an alloy containing approximately 98% silver (Ag), platinum (Pt), and copper (Cu) by weight, an alloy containing silver, copper, and gold or an alloy containing silver, ruthenium (Ru), and copper.

[0063]

Then, as shown in Fig. 8(c), the reflective film 302′ is patterned by photolithographic and etching processes to form an opening 309 and a reflective film 302 in the interior of the sealant frame and the reflective conductive films 312, 362, and 372, as well as a reflective conductive

film 352, in the exterior of the sealant frame.

[0064]

As shown in Fig. 8(d), a protective film 303 is formed using a dielectric laminate or SiO_2 in the interior of the sealant frame to cover the reflective film 302. As shown in Fig. 8(e), red (R), green (G), and blue (B) color filters 305 having a predetermined array are formed on the protective film 303 using photolithographic, printing, and transferring technologies. Each color filter 305 is composed of an acrylic resin containing one of the red, green, and blue coloring agents. The resin applied on the protective film 303 must be dried and cured by a heat treatment at approximately 200°C. Since the crystal grain growth in the silver alloy constituting the reflective film 302 is suppressed by the protective film 303, the reflectance of the reflective film 302 is not decreased.

[0065]

In order to prevent a decrease in contrast due to color mixing between the adjoining sub-pixels, a shading layer of chromium or the like may be provided at the gaps between the color filters 305 but is not depicted in this embodiment.

[0066]

As shown in Fig. 9(f), the planarization (overcoat) film 307 of an acrylic resin or an epoxy resin is formed to protect and planarize the color filters 305. As shown in

Fig. 9(g), the transparent conductive layer 314′ of ITO or the like is formed on the planarization film 307 by sputtering or the like.

[0067]

As shown in Fig. 9(h), the transparent conductive layer 314′ is patterned using a photolithographic process and an etching process to form the segment electrodes 314 in the interior of the sealant frame and the transparent conductive film 354 and the reflective conductive films 314, 364, and 374 in the exterior of the sealant frame. The peripheries of the segment electrodes 314 and the transparent conductive films 354, 364, and 374 are not removed so as to come into contact with the protective film 303 such that the reflective conductive films 352, 362, and 372, respectively, are not exposed. Since the surfaces of the reflective conductive films 312, 352, 362, and 372 are thereby not exposed after the conductive layer 314′ is exposed, these layers are prevented from corrosion and separation.

[0068]

As shown in Fig. 9(i), the alignment film 308 of an organic film such as polyimide is formed and the alignment film 308 is subjected to rubbing treatment. In the subsequent steps (not shown in the drawings), the viewer-side substrate 200 and the backside substrate 300 are bonded to each other with the sealant 110 containing adequately

dispersed conductive particles 114. A liquid crystal 160 is dropwise supplied to the opening of the sealant 110 under vacuum. After the pressure is backed to normal pressure so that the liquid crystal 160 spreads over the interior of the sealant frame, the opening is sealed with a sealant 112. As described above, the driver IC chips 122 and 124 and the FPC board 150 are mounted to complete the liquid crystal panel 100 shown in Fig. 1.

[0069]

<Display Operation, etc.>

The display operation of the liquid crystal device in accordance with such a configuration will be described in brief. The driver IC chip 122 applies a selection voltage to common electrodes 214 in a predetermined order every horizontal scanning period, while the driver IC chip 124 supplies segment signals corresponding to the display information of one sub-pixel line which lies at these common electrodes 214 to the corresponding segment electrodes 314. The alignment of the liquid crystal 160 in the sub-pixels in this region is independently controlled based on the differences between the voltages applied to the common electrodes 214 and the voltages applied to the segment electrodes 314.

[0070]

With reference to Figs. 2 and 3, the external light

from the viewer passes through the polarizer 121 and the retarder 123 to be polarized to a predetermined state. The light passes through the viewer-side substrate 200, the common electrodes 214, the liquid crystal 160, the segment electrodes 314, the color filter 305, and the protective film 303, and reaches the reflective film 302. The light is reflected thereby and passes through the above route backward. Thus, in the reflective type, the amount of the light which is reflected by the reflective film 302, passes through the polarizer 121, and is visible by the viewer is independently controlled in each sub-pixel in response to a change in alignment of the liquid crystal 160 between the common electrode 214 and the segment electrode 314.

[0071]

In the reflective type, a larger amount of shorter-wavelength (blue) light is reflected by the protective film 303 which lies above the reflective film 302 rather than by the reflective film 302. The reason for providing the protective film 303 in this embodiment is as follows. As shown in Fig. 10, the reflectance of silver or the silver alloy is superior in the entire visible light region, but is not so flat as that of aluminum and tends to decrease at the shorter wavelength side. As a result, the light reflected by the reflective film 302 less contains blue light components and thus is yellowish, adversely affecting color

reproducibility in a color display mode. Thus, the protective film 303 is provided so that large amounts of blue light components are reflected by the protective film 303 rather than by the reflective film 302.

[0072]

When a backlight (not shown in the drawing) lying at the rear face of the backside substrate 300 is turned on, the light from the backlight passes through the polarizer 131 and the retarder 133 and is polarized to a predetermined state. The light further passes through the backside substrate 300, the openings 309, the protective film 303, the color filter 305, the segment electrodes 314, the liquid crystal 160, the common electrodes 214, the viewer-side substrate 200, and the polarizer 121, and is emitted towards the viewer. Thus, also, in the transmissive type, the amount of the light which passes through the openings 309 and the polarizer 121 and is observed by the viewer is independently controlled in each sub-pixel by a change in alignment of the liquid crystal 160 between the common electrodes 214 and the segment electrode 314.

[0073]

Since the liquid crystal device in accordance with this embodiment functions as a reflective type when the external light is sufficient and a transmissive type by switching on the backlight when the external light is insufficient, and

thus can perform display in both types. Since the reflective film 302 reflecting the light is formed of elemental silver or a silver alloy primarily composed of silver and is covered by the protective film 303 so as to moderate crystal grain growth in the silver alloy constituting the reflective film 302, light returning towards the viewer is increased due to high reflectance. Accordingly, this liquid crystal device performs bright display when this functions as a reflective type.

[0074]

Since the leads 350, 360, and 370 have laminate configurations which include the transparent conductive films 354, 364, and 374, respectively, and the segment electrodes 352, 362, and 372, respectively, which are composed of the same conductive layer as the reflective film 302, these leads exhibit lower resistance. Since the segment electrode 314 is also laminated with the reflective conductive film 312 in the exterior of the sealant frame and thus exhibits lower resistance.

[0075]

Since the segment electrodes 314 and the transparent conductive films 354, 364, and 374 cover the reflective conductive films 312, 352, 364, and 374, respectively, so that these layers are not exposed, corrosion and the like due to moisture penetration is prevented, thus enhancing

reliability.

[0076]

In the region for mounting the driver IC chip 124, the segment electrodes 314 are not provided with the transparent conductive film 312. In the region contained in the sealant 110 and the region for mounting the driver IC chip 122, the leads 350 are provided with only the transparent conductive films 354 and thus not provided with the reflective conductive films 352. In the region for mounting the driver IC chip 122 and the region for connecting the FPC board 150, the leads 360 are provided with only the transparent conductive film 364 and thus not provided with the reflective conductive film 362. In the region for mounting the driver IC chip 124 and the region for connecting the FPC board 150, the leads 370 are provided with only the transparent conductive film 374 and thus not provided with the reflective conductive film 372.

[0077]

Since the silver alloy exhibits poor adhesiveness to other materials, it is not desirable that this alloy be provided at portions in which stress is applied. If a decrease in resistance of the leads has priority, it is preferable that the reflective conductive film be formed over the entire underlayer of the segment electrode or the transparent conductive film. In such a configuration,

however, insufficient connection of the driver IC in the mounting step may cause separation of the reflective conductive film from the substrate due to low adhesiveness, for example, when the driver IC chip is exchanged due to unsatisfactory connection. Moreover, the conductive particles 114, 134, and 144 are composed of nonconductive particles of plastic or the like of which the surfaces are covered by a metal such as gold (Au). This covering metal exhibits superior adhesiveness to a transparent conductive single layer. Thus, in this embodiment, only the transparent conductive film of ITO or the like is deposited and a reflective conductive film of a silver alloy is not deposited in the region included in the sealant 110, the regions for mounting the driver IC chips 122 and 124, and the region for bonding the FPC board 150 to prevent separation of the reflective conductive film.

[0078]

Since the common electrodes 214 provided on the viewer-side substrate 200 are extracted to the backside substrate 300 via the conductive particles 114 and the leads 350, and are further extracted to the connection to the FPC board 150 via the leads 360, the connection of the FPC board 150 is achieved on one side regardless of a passive matrix type in this embodiment. Thus, the mounting process is simplified.

[0079]

<Various Applications>

In the above embodiment, the common electrodes 214 are driven by the driver IC chip 122 and the segment electrodes 314 are driven by the driver IC chip 124. The present invention, however, is not limited to this configuration. For example, the present invention is applicable to a one-chip type including both ICs, as shown in Fig. 11.

[0080]

The liquid crystal device shown in this drawing has a plurality of common electrodes 214 extending in the X direction on the viewer-side substrate 200 as in the other embodiment, but differs from this embodiment in that the upper half common electrodes 214 and the lower half common electrodes 214 are extracted from the left and the right, respectively, via the leads 350 and are connected to a driver IC chip 126. The driver IC chip 126 is a one-chip IC including the driver IC chip 122 and the driver IC chip 124 in the above embodiments, and is connected to the segment electrodes 314 in the exterior of the frame of the sealant 110. Although each lead 310 is a laminate of the reflective conductive film 312 and the segment electrode 314 in the exterior of the sealant frame, the driver IC chip 126 is connected to the segment electrodes 314 in the region of the connection with the driver IC chip 126 since the reflective conductive film 312 is not deposited in this region. The

FPC board 150 supplies signals for controlling the driver IC chip 126 from an external circuit (not shown in the drawing) via the leads 360 (370). In the liquid crystal device shown in Fig. 8, the common electrodes 214 may be extracted from one side if the number of the common electrodes 214 is small.

[0081]

As shown in Fig. 12, the present invention is also applicable to a type in which the driver IC chip 126 is not mounted on the liquid crystal panel 100. In the liquid crystal device shown in this drawing, the driver IC chip 126 is mounted on the FPC board 150 by, for example, a flip chip technology. Alternatively, the driver IC chip 126 may be bonded with inner leads by a tape automated bonding (TAB) technology and may be bonded to the liquid crystal panel 100 with outer leads. In such a configuration, however, the number of the connections to the FPC board 150 increases as the pixels increase.

[0082]

In the embodiment, the reflective film 302 of a silver alloy is electrically floating. As shown in Fig. 13, the reflective film 302 may be patterned into the same shape as that of the second electrode 314, and as shown in Fig. 14, this may be connected to the second electrode 314 at the connection CP. Since this configuration prevents capacitive

coupling between the reflective film 302 and the second electrode 314, it is not necessary that the thicknesses of the protective film 303, the color filter 305, and the planarization film 307 are increased so that the distance between the reflective film 302 and the second electrode 314 is approximately 2 μm.

[0083]

<Miscellaneous>

In the above embodiment, a transflective liquid crystal device is described. However, the present invention is also applicable to a reflective liquid crystal device not having openings 309. In the reflective type, a front light which emits light from the viewer side may be provided instead of the backlight, if necessary.

[0084]

In the above embodiments, connection between the common electrodes 214 and the leads 350 is achieved with conductive particles 114 contained in the sealant 110. However, the connection may be achieved in another region provided at the exterior of the frame of the sealant 110.

[0085]

Since the common electrode 214 and the segment electrode 314 has a mutually relative relationship, the segment electrodes may be formed on the viewer-side substrate 200 while the common electrodes may be formed on

the back substrate 300.

[0086]

The liquid crystal is driven without using switching elements in the embodiment and the modification, but may be driven by thin film diodes (TFDs) or thin film transistors (TFTs) provided in the sub-pixels. Moreover, the reflective layer 302 may be covered by the protective film 303.

[0087]

Although a TN liquid crystal is used in the above embodiment and modification, the liquid crystal device may be a bistable type having a memory effect such as a bistable twisted nematic (BTN) type and a ferroelectric type, a polymer dispersion type, or a guest-host type in which a dye (guest) having different visible light absorbencies between the long axis and the short axis of molecules is dissolved in a liquid crystal (host) having a predetermined molecular arrangement so that the dye molecules and the liquid crystal molecules are arranged in parallel. Moreover, the configuration may be a vertical (homeotropic) alignment in which the liquid crystal molecules are arranged perpendicular to the both substrates when no voltage is applied and parallel to the both substrates when a voltage is applied, or may be a parallel (homogeneous) alignment in which the liquid crystal molecules are arranged parallel to the both substrates when no voltage is applied and

perpendicular to the both substrates when a voltage is applied. Accordingly, the present invention can be applied to various types of liquid crystals and alignment systems.

[0088]

<Electronic Devices>

Several electrooptical devices using the above liquid crystal device will now be described.

[0089]

<1: Mobile Computer>

An example in which the liquid crystal device according to this embodiment is applied to a mobile personal computer will now be described. Fig. 15 is an isometric view illustrating the configuration of this personal computer. In the drawing, the personal computer 1100 is provided with a body 1104 including a keyboard 1102 and a liquid crystal display unit 1106. The liquid crystal display unit 1106 is provided with a backlight (not shown in the drawing) at the back face of the above-described liquid crystal panel 100. The display is thereby visible as a reflective type when external light is sufficient or a transmissive type when external light is insufficient.

[0090]

<2: Portable Phone>

Next, an example in which the liquid crystal device is applied to a display section of a portable phone will now be

described. Fig. 16 is an isometric view illustrating the configuration of the portable phone. In the drawing, the portable phone 1200 is provided with a plurality of operation keys 1202, an earpiece 1204, a mouthpiece 1206, and the above-mentioned liquid crystal panel 100. This liquid crystal panel 100 may be provided with a backlight (not shown in the drawing) at the back face thereof for improving the visibility.

[0091]

<3: Digital Still Camera>

Next, a digital still camera using the liquid crystal device as a finder will be described. Fig. 17 is an isometric view illustrating the configuration of the digital still camera and the connection to external devices in brief.

[0092]

Typical cameras sensitize films based on optical images from objects, whereas the digital still camera 1300 generates imaging signals from the optical image of an object by photoelectric conversion using, for example, a charge coupled device (CCD). The digital still camera 1300 is provided with the liquid crystal panel 100 at the back face of a case 1302 to perform display based on the imaging signals from the CCD. Thus, the liquid crystal panel 100 functions as a liquid crystal finder for displaying the

object. A photo acceptance unit 1304 including optical lenses and the CCD is provided at the front side (behind in the drawing) of the case 1302.

[0093]

When a cameraman determines the object image displayed in the liquid crystal panel 100 and releases the shutter 1306, the image signals from the CCD are transmitted and stored to memories in a circuit board 1308. In the digital still camera 1300, video signal output terminals 1312 and input/output terminals 1314 for data communication are provided on a side of the case 1302. As shown in the drawing, a television monitor 1430 and a personal computer 1430 are connected to the video signal output terminals 1312 and the input/output terminals 1314 for data communication, respectively, if necessary. The imaging signals stored in the memories of the circuit board 1308 are output to the television monitor 1430 and the personal computer 1440, by a given operation.

[0094]

Examples of electrooptical devices, other than the personal computer shown in Fig. 15, the portable phone shown in Fig. 16, and the digital still camera shown in Fig. 17, include liquid crystal television sets, view-finder-type and monitoring-type video tape recorders, car navigation systems, pagers, electronic notebooks, portable calculators,

word processors, workstations, TV telephones, point-of-sales system (POS) terminals, and devices provided with touch panels. Of course, the above liquid crystal device can be applied to display sections of these electronic devices.

[0095]

[Advantages]

As described above, according to the present invention, when the silver alloy is used as the reflective film in the reflective or transflective liquid crystal device, a decrease in reflectance of the reflective film during the subsequent high-temperature treatment is prevented.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is an isometric view illustrating an overall configuration of a liquid crystal device in accordance with an embodiment of the present invention.

[Fig. 2]

Fig. 2 is a partial cross-sectional view when a liquid crystal panel constituting the liquid crystal device is broken along the X direction.

[Fig. 3]

Fig. 3 is a partial cross-sectional view when the liquid crystal panel is broken along the Y direction.

[Fig. 4]

Fig. 4 is a plan view illustrating the configuration of

a pixel and the configuration of the vicinity of a sealant in the liquid crystal panel.

[Fig. 5]

Fig. 5 is a cross-sectional view taken from line A-A' in Fig. 4.

[Fig. 6]

Fig. 6 is a partial cross-sectional view illustrating the vicinity of the region for mounting the driver IC chip in the liquid crystal panel.

[Fig. 7]

Fig. 7 is a partial plan view illustrating the vicinity of the region for mounting the driver IC in a backside substrate of the liquid crystal panel.

[Fig. 8]

Figs. 8(a) to 8(e) are cross-sectional views of a manufacturing process of the backside substrate in the liquid crystal panel.

[Fig. 9]

Figs. 9(f) to 9(i) are cross-sectional views of the manufacturing process of the backside substrate in the liquid crystal panel.

[Fig. 10]

Fig. 10 is a graph illustrating reflectance characteristics of silver and aluminum.

[Fig. 11]

Fig. 11 is an isometric view illustrating the configuration of a liquid crystal panel according to a modification of the present invention.

[Fig. 12]

Fig. 12 is an isometric view illustrating the configuration of a liquid crystal panel according to another modification of the present invention.

[Fig. 13]

Fig. 13 is a partial cross-sectional view when a liquid crystal panel according to another modification of the present invention is broken along the X direction.

[Fig. 14]

Fig. 14 is a partial cross-sectional view when the liquid crystal panel according to the same modification of the present invention is broken along the Y direction.

[Fig. 15]

Fig. 15 is an isometric view of a personal computer as an example of the electronic devices using the liquid crystal panel in accordance with the embodiments.

[Fig. 16]

Fig. 16 is an isometric view of a portable phone as an example of the electronic devices using the liquid crystal panel.

[Fig. 17]

Fig. 17 is an isometric view at the backside of a

digital still camera as an example of the electronic devices using the liquid crystal panel.

[Reference Numerals]

100: liquid crystal panel

110: sealant

112: sealant

114: conductive particles (conductors)

122, 124, 126: driver IC chips

129a, 129b: projection electrodes

130, 140: adhesives

134, 144: conductive particles

150: FPC board

160: liquid crystal

200: substrate (first substrate)

208: alignment film

214: common electrode (first transparent electrode)

300: substrate (second substrate)

301: underlying film

302: reflective film

303: protective film

305: color filter

307: planarization film

308: alignment film

309: opening

312, 352, 362, 372: reflective conductive films

314: segment electrode (second transparent electrode)

350, 360, 370: leads (first, second, and third leads)

354, 364, 374: transparent conductive films

1100: personal computer

1200: portable phone

1300: digital still camera

[Name of Document] ABSTRACT

[Abstract]

[Object] To prevent a decrease in reflectance of a reflective film during a subsequent heat treatment, when a silver alloy is used as the reflective film in a reflective or transflective liquid crystal device.

[Solving Means] A liquid crystal device has a configuration including substrates 200 and 300 bonded to each other with a sealant 110 at a predetermined gap and a liquid crystal 160 enclosed in the gap. Transparent common electrodes 214 are provided on the inner face of the substrate 200, whereas an underlying film 301, a reflective film 302 composed of a silver alloy, a protective film 303 covering the reflective film 302, a color filter 305, a planarization film 307, and segment electrodes 314 are provided on the inner face of the backside substrate 300. Since the protective film 303 suppresses the crystal grain growth of the reflective film 302 at a high-temperature treatment when the color filter 305 is formed, a decrease in reflectance is avoided.

[Selected Figure] Fig. 2

【Name of Document】 Drawings

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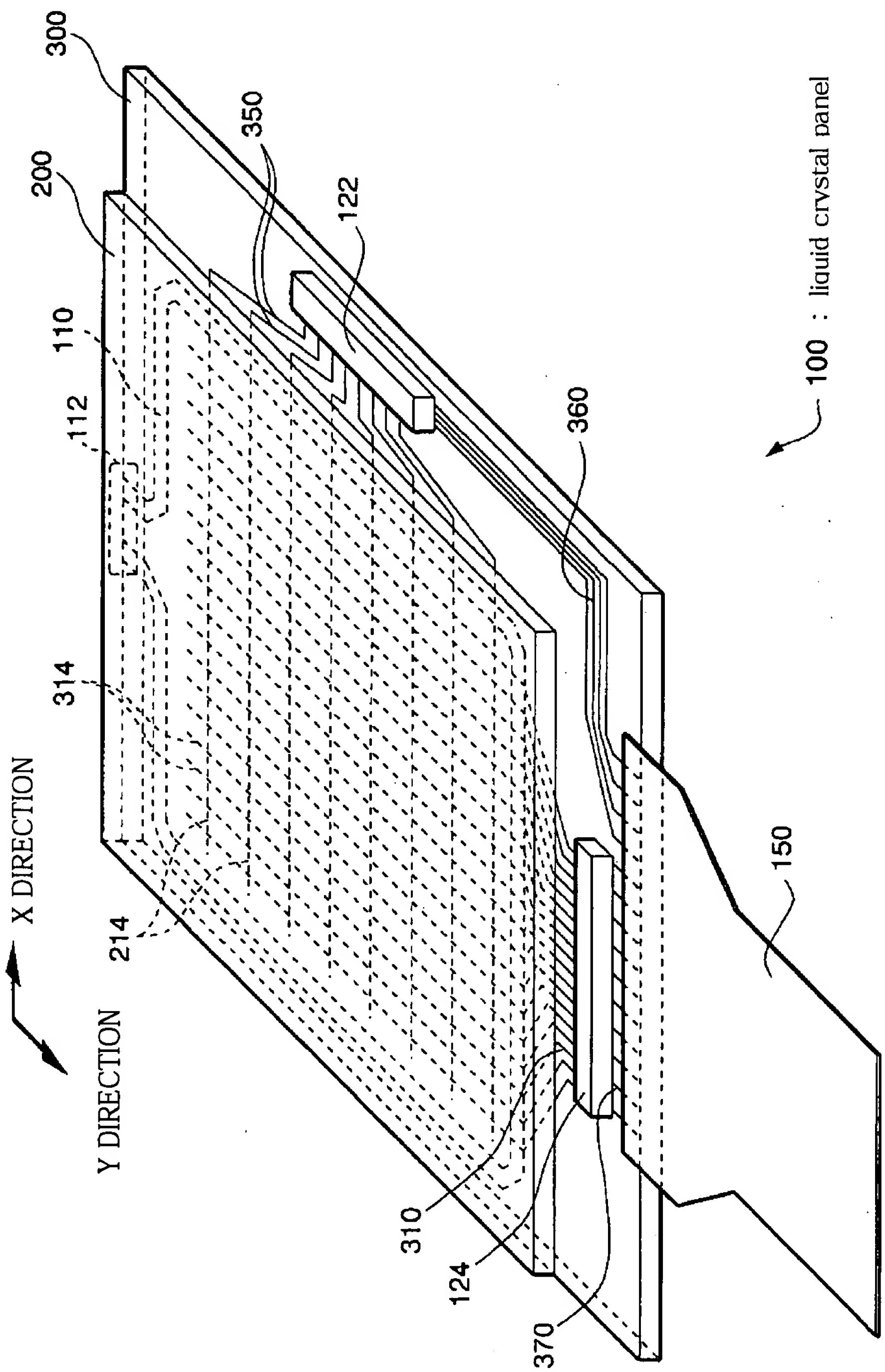

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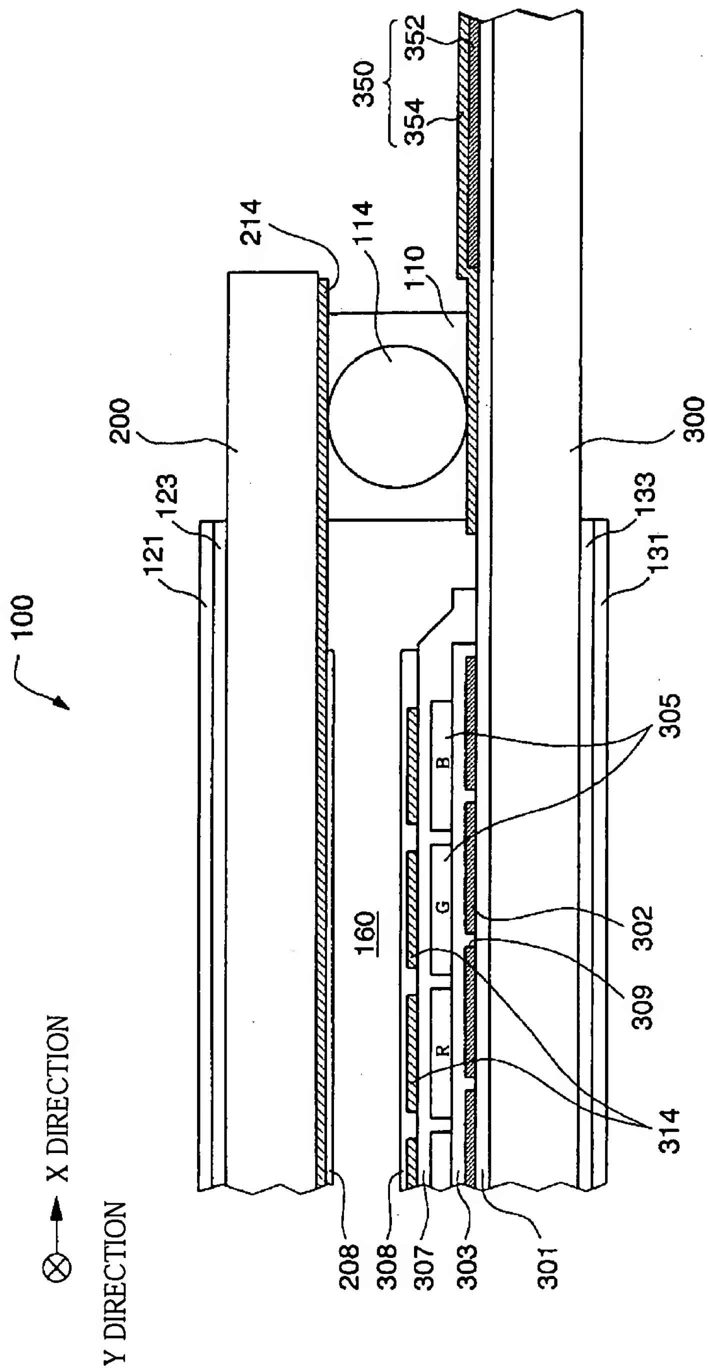
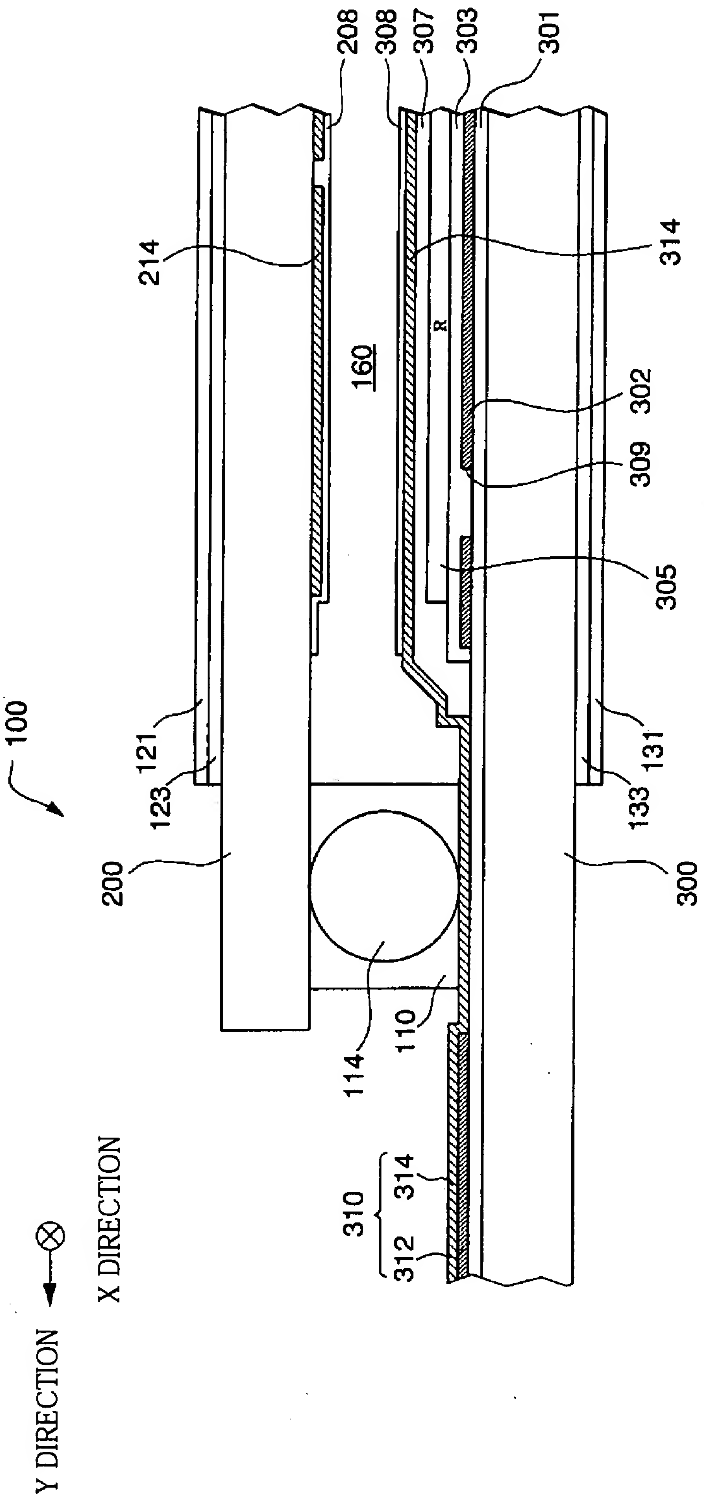

100
350
352
354
214
114
110
200
300
123
121
133
131
305
B
G
R
160
302
309
314
208
308
307
303
301
X DIRECTION
Y DIRECTION

【F I G. 3】


208
308
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303
301
214
314
160
R
302
309
305
100
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133
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300
114
110
310
314
312
Y DIRECTION
X DIRECTION

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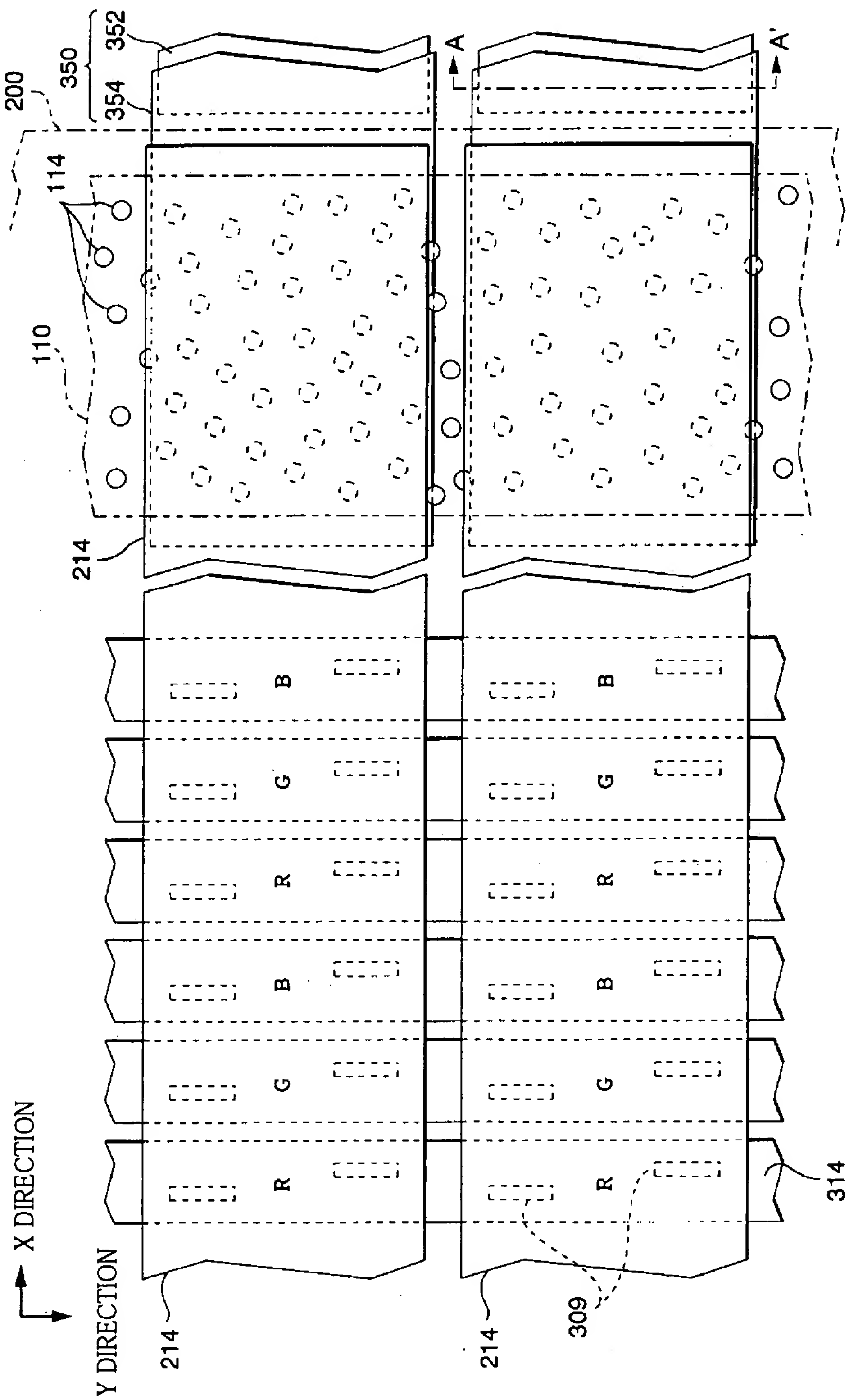
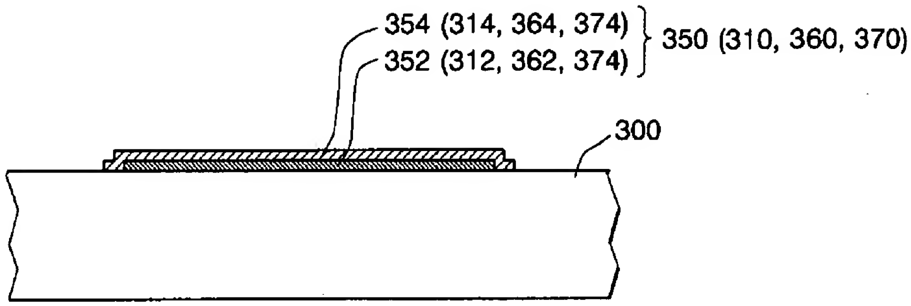


350
352
354
200
114
110
214
A
A'
B
G
R
B
G
R
309
314
X DIRECTION
Y DIRECTION

【FIG. 5】



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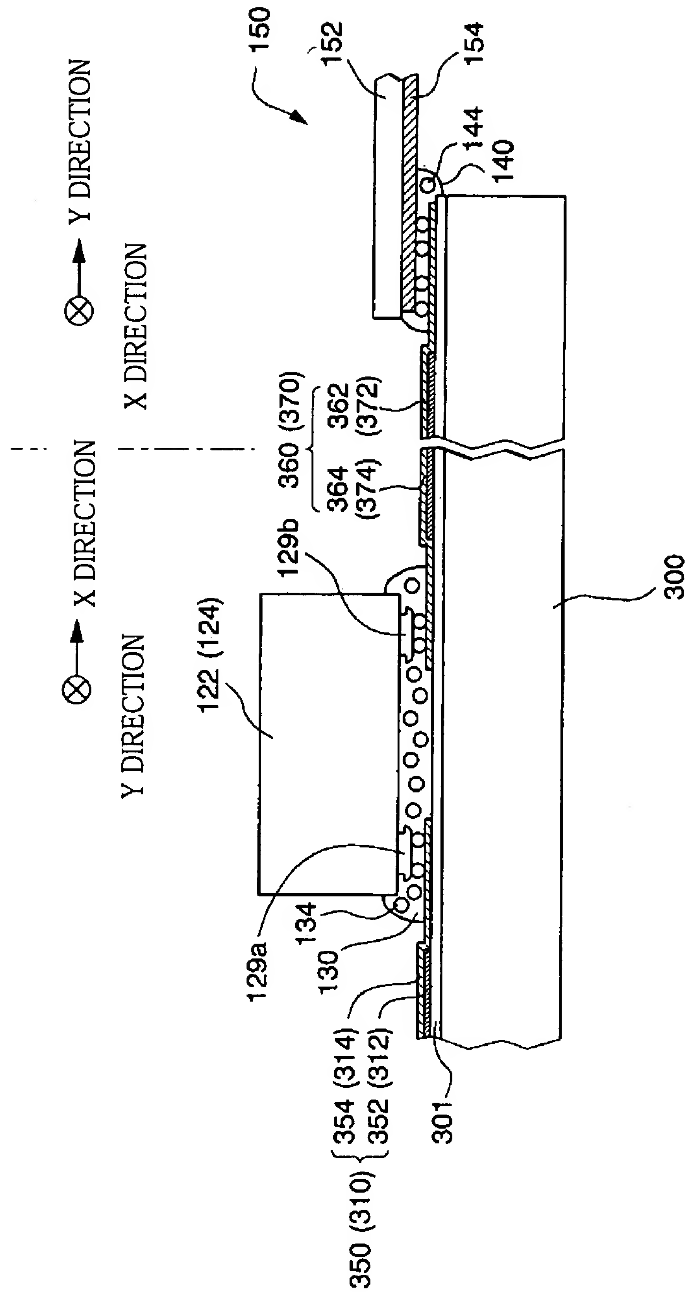
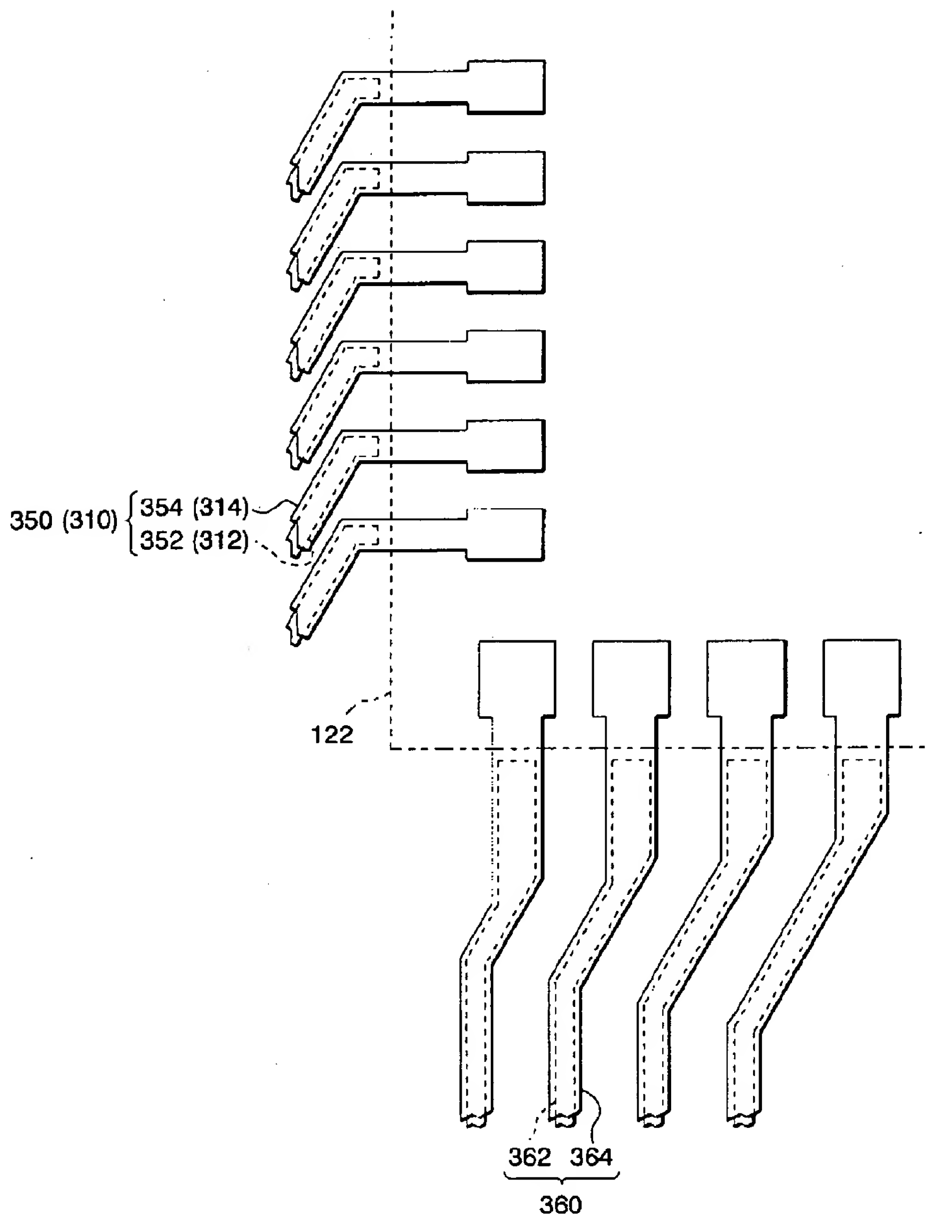

150
152
154
144
140
Y DIRECTION
X DIRECTION
X DIRECTION
Y DIRECTION
360 (370)
362 (372)
364 (374)
129b
300
122 (124)
129a
134
130
350 (310)
354 (314)
352 (312)
301

【F I G. 7】



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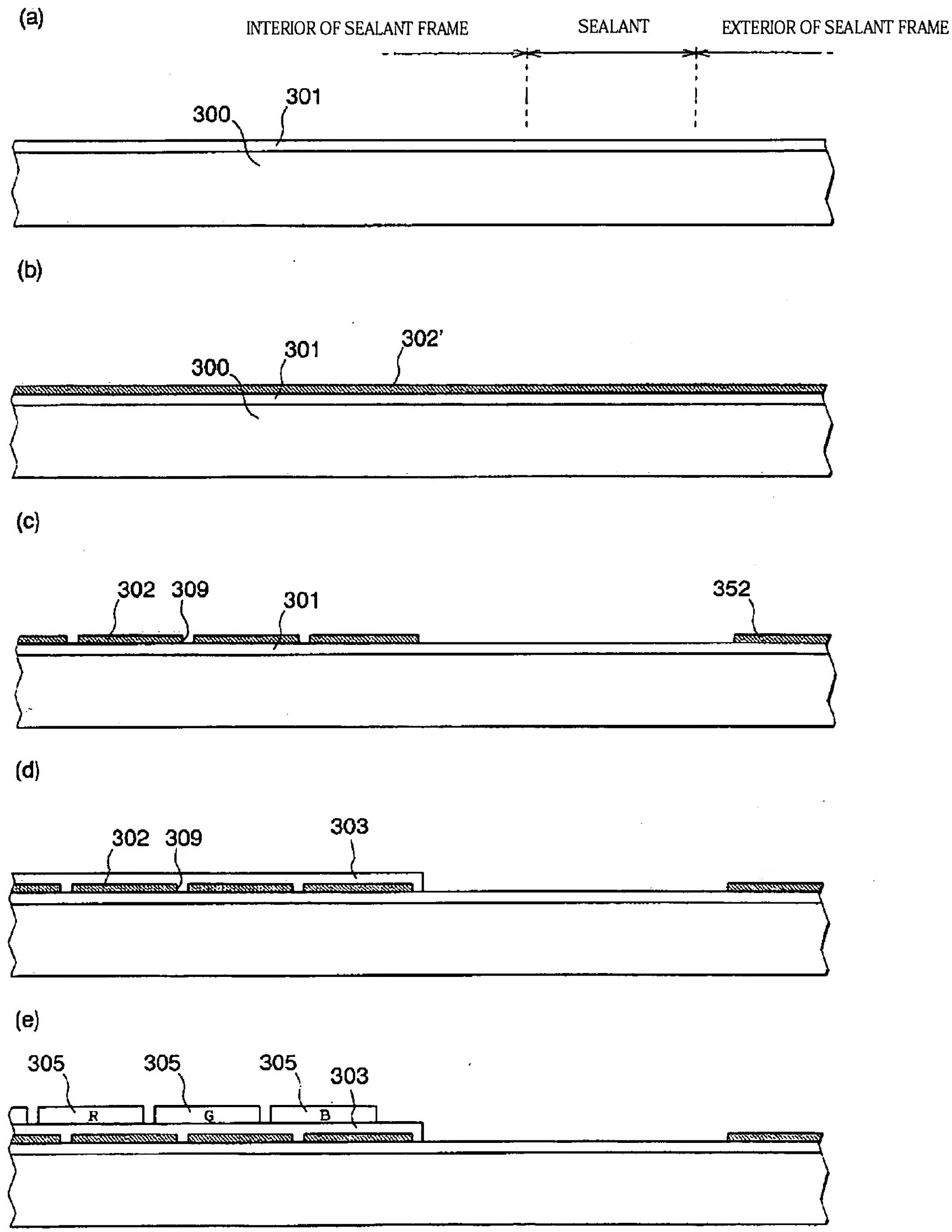
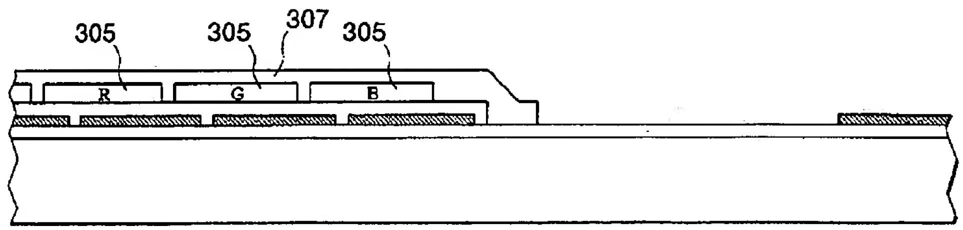
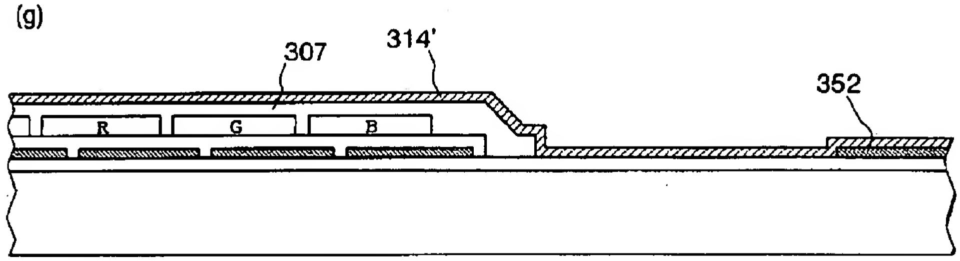

(a)
INTERIOR OF SEALANT FRAME
SEALANT
EXTERIOR OF SEALANT FRAME
300
301
(b)
300
301
302'
(c)
302
309
301
352
(d)
302
309
303
(e)
305
305
305
303
R
G
B

【F I G. 9】

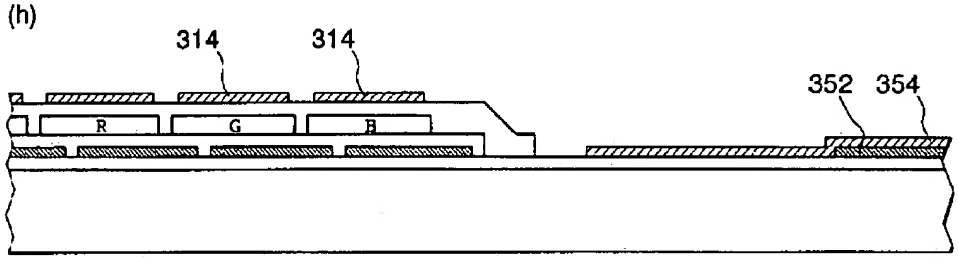
(f)


305
305
307
305
R
G
B

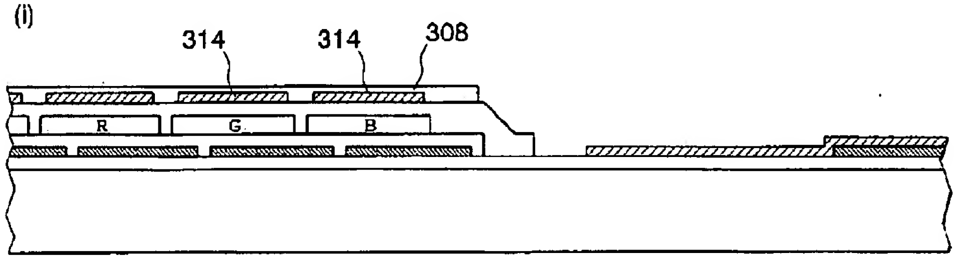
(g)


307
314'
352
R
G
B

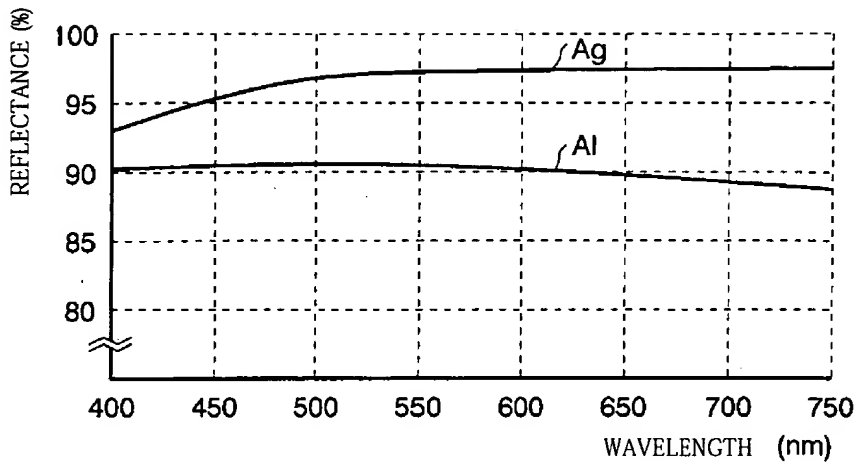
(h)


314
314
352
354
R
G
B

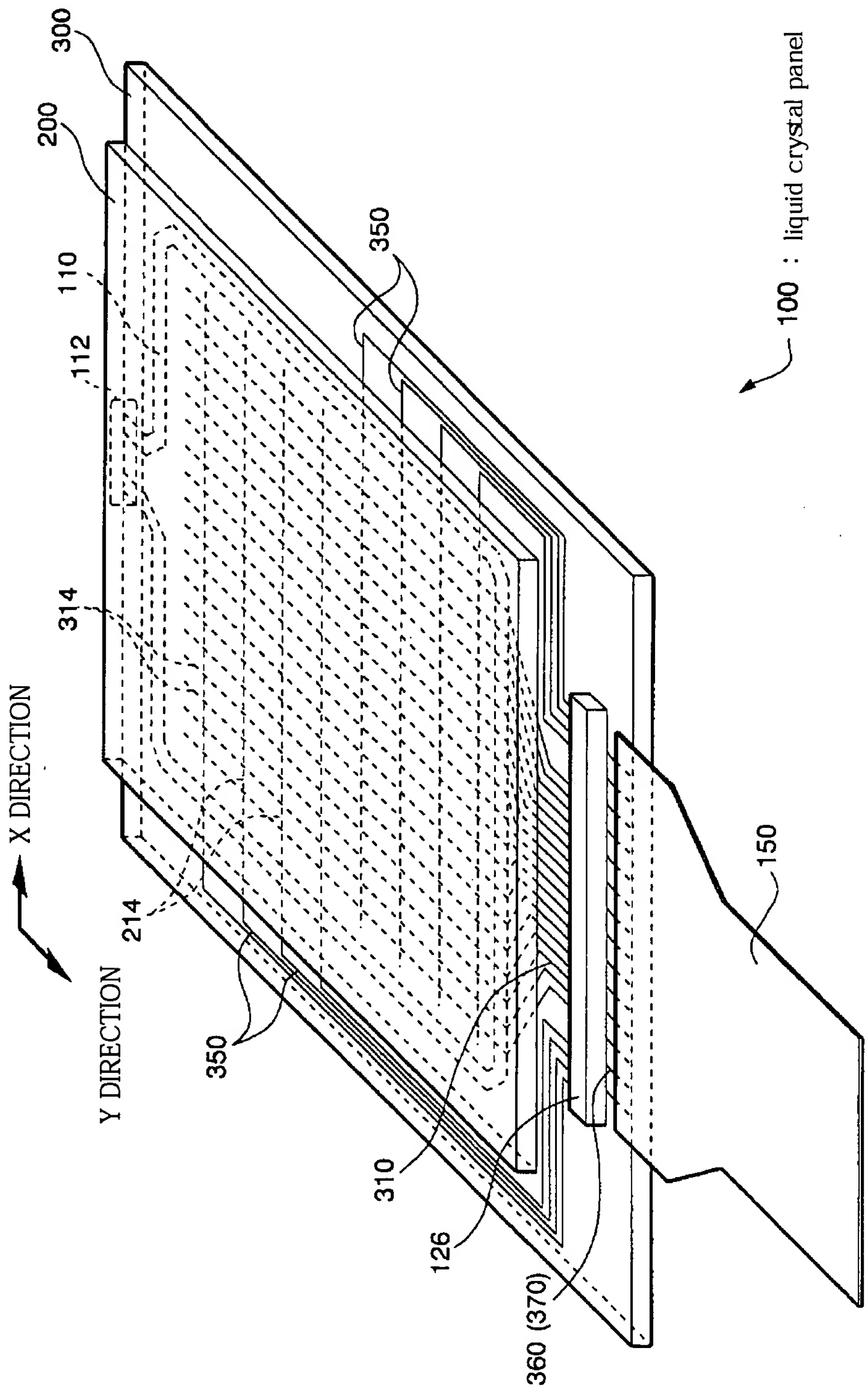
(i)


314
314
308
R
G
B

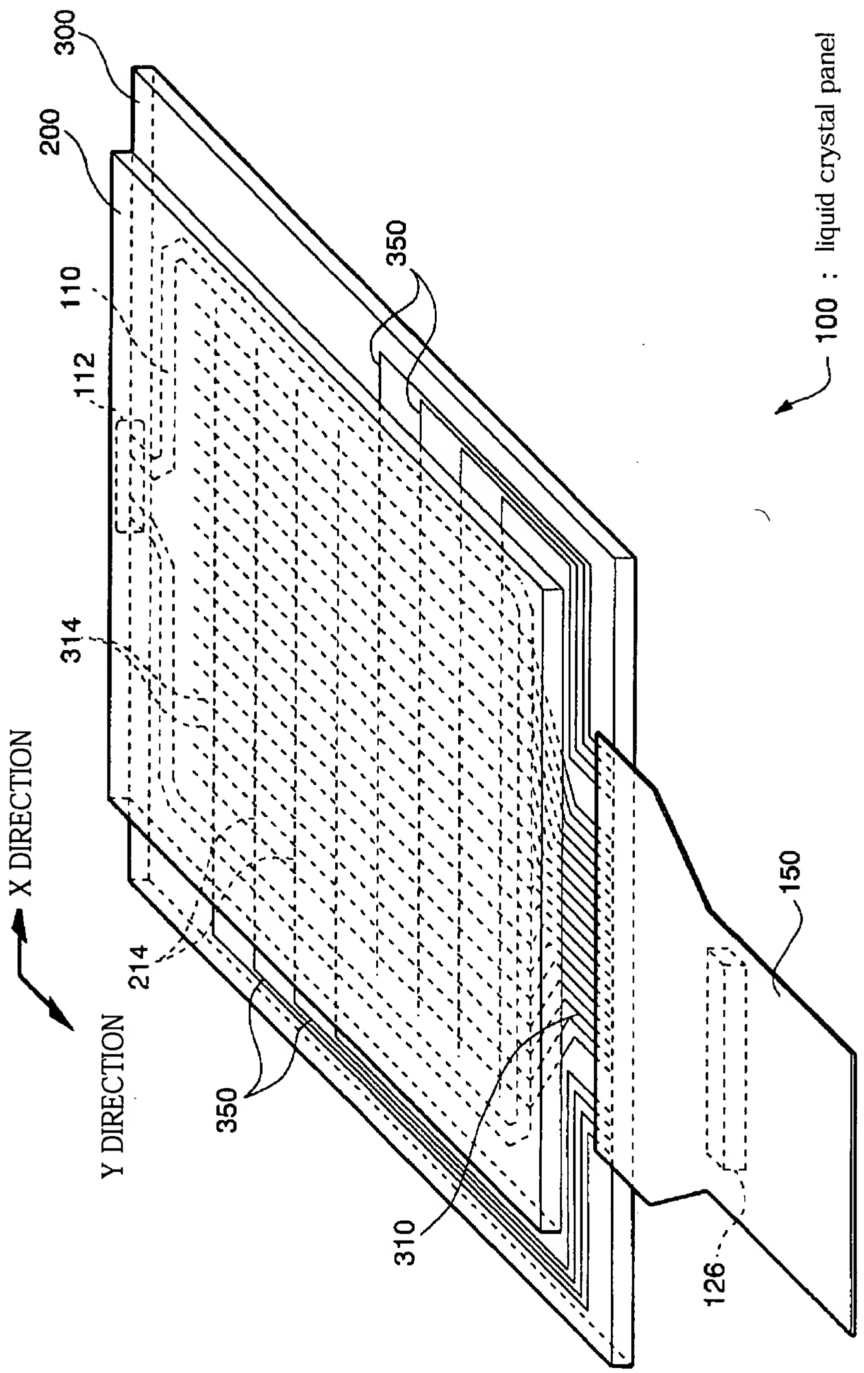
【F I G. 1 0】


REFLECTANCE (%)
100
95
90
85
80
Ag
Al
400
450
500
550
600
650
700
750
WAVELENGTH (nm)

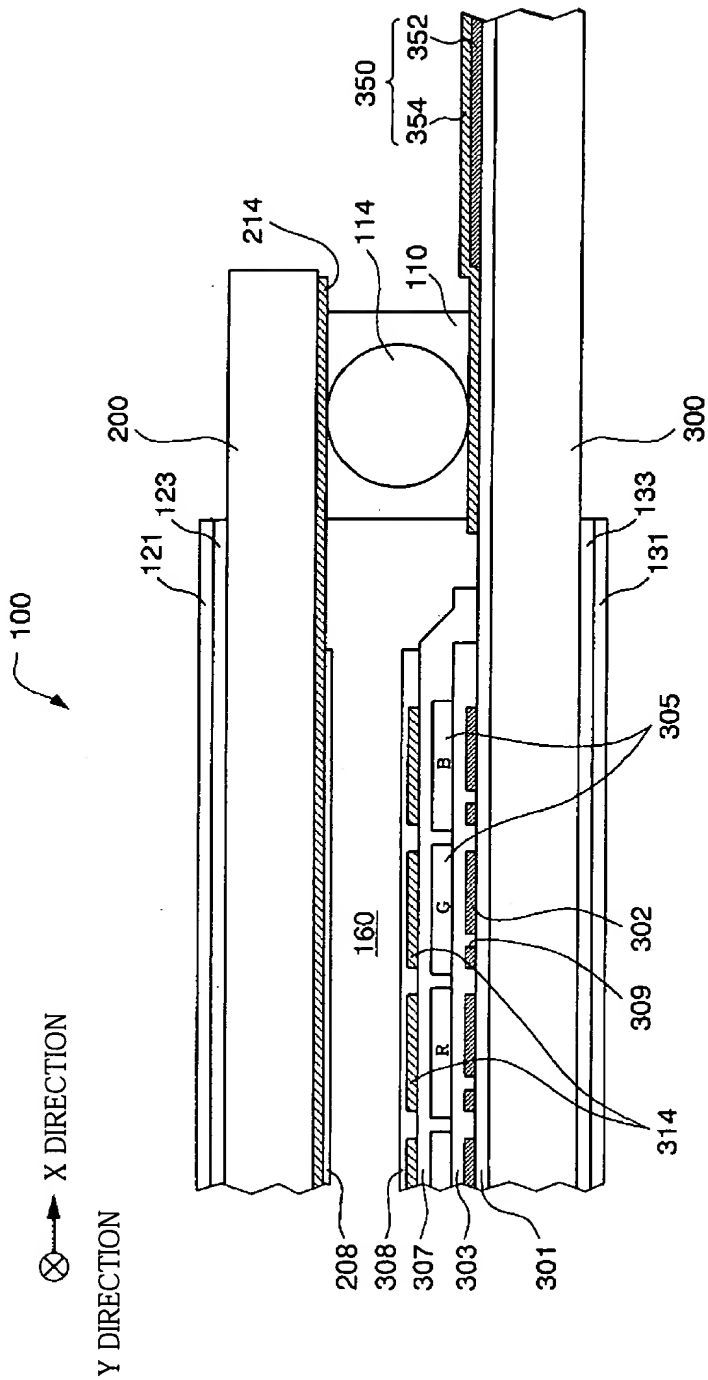
【FIG. 11】


300
200
110
112
314
350
100 : liquid crystal panel
X DIRECTION
Y DIRECTION
214
350
150
310
126
360 (370)

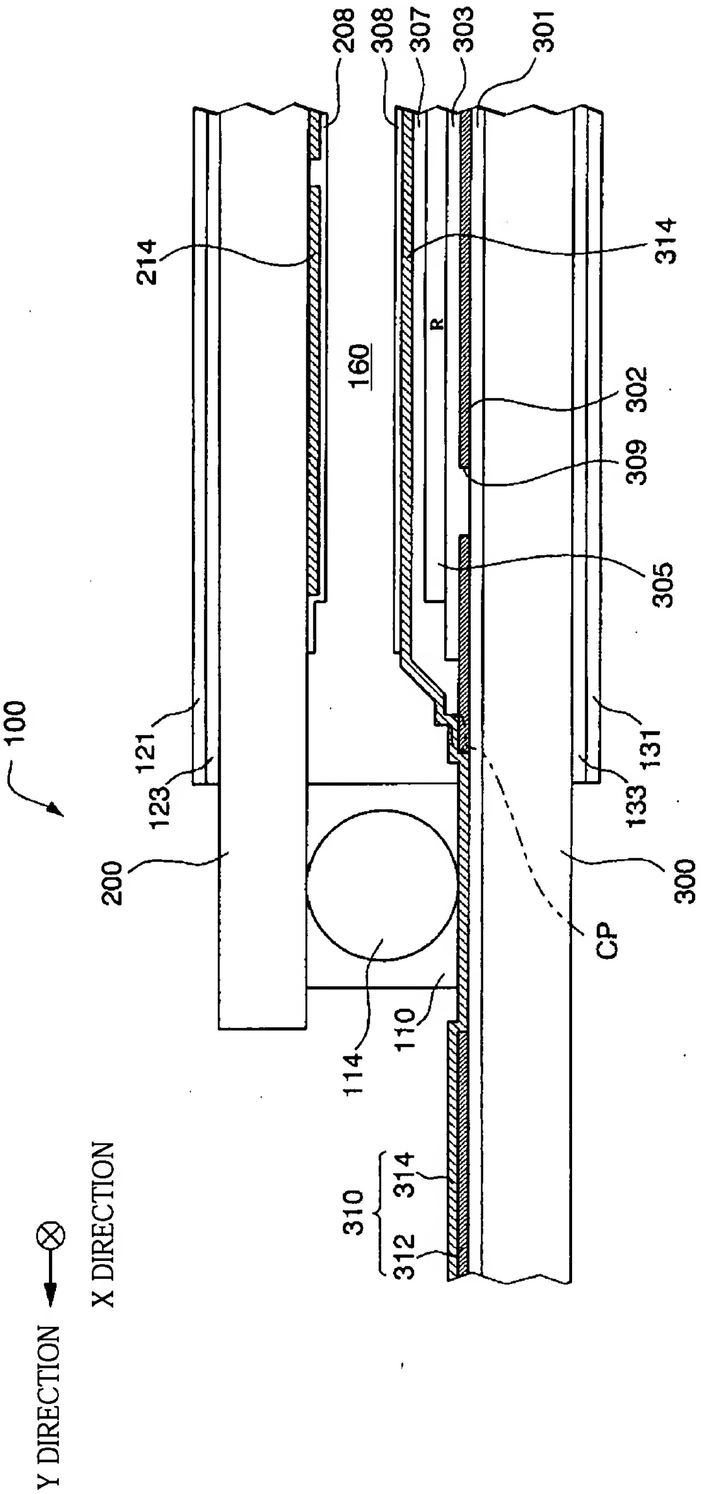
【F I G. 1 2】


300
200
110
112
350
314
X DIRECTION
Y DIRECTION
214
350
310
150
126
100 : liquid crystal panel

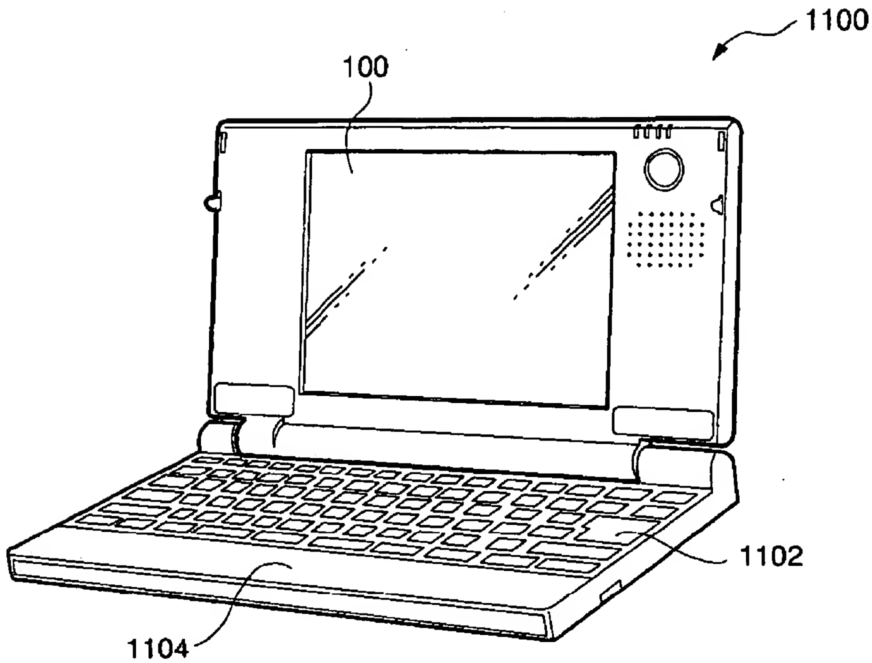
【FIG. 13】


350
352
354
214
114
110
200
300
123
121
133
131
100
305
B
G
R
160
302
309
314
X DIRECTION
Y DIRECTION
208
308
307
303
301

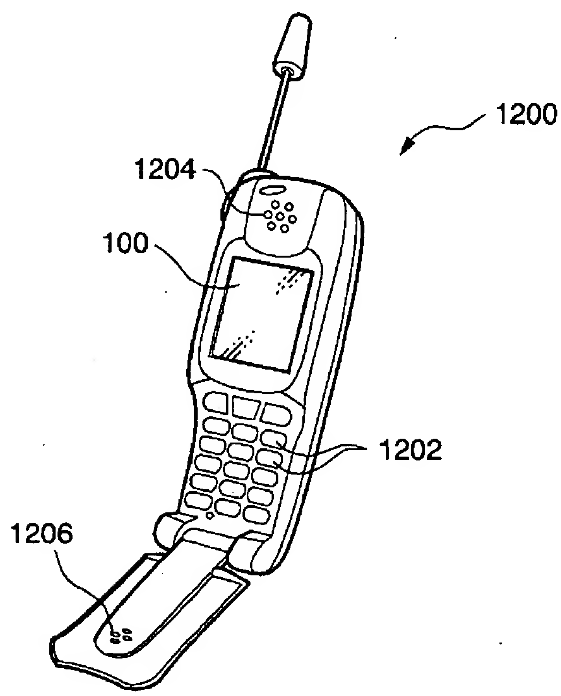
【F I G. 1 4】


208
308
307
303
301
214
314
160
R
302
309
305
100
121
123
131
133
200
300
CP
114
110
310
314
312
X DIRECTION
Y DIRECTION

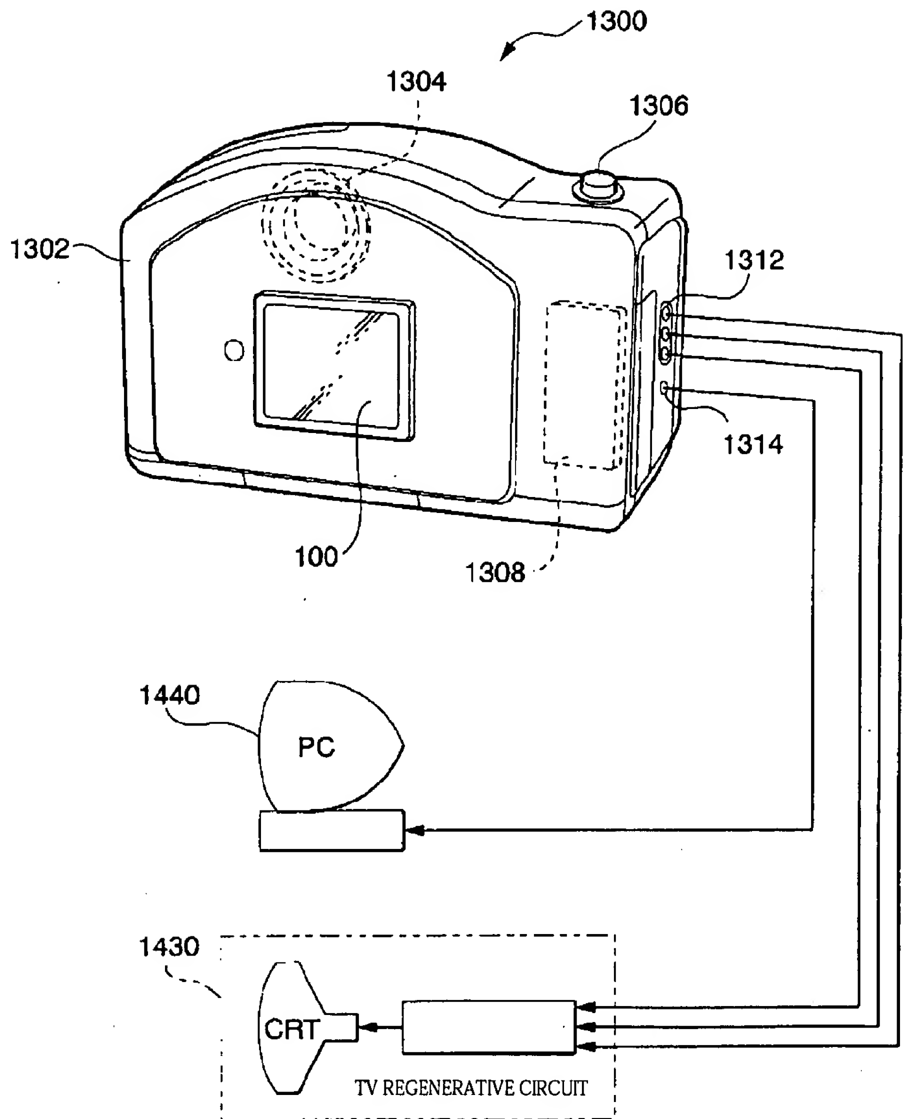
【F I G. 1 5】



【F I G. 1 6】



【F I G. 1 7】


1300
1304
1306
1302
1312
1314
100
1308
1440
PC
1430
CRT
TV REGENERATIVE CIRCUIT